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(12) UK Patent Application (19) GB (11) 2 382 560 (13) A

(43) Date of A Publication 04.06.2003

(21) Application No 0128548.5

(22) Date of Filing 29.11.2001

(71) Applicant(s)
Rockware Glass Limited
(Incorporated in the United Kingdom)
Headlands Glassworks, Headlands Lane,
KNOTTINGLEY, West Yorkshire,
WF11 0HP, United Kingdom

(72) Inventor(s)
John Parkes

(74) Agent and/or Address for Service
Franks & Co
9 President Buildings, Savile Street East,
SHEFFIELD, S4 7UQ, United Kingdom

(51) INT CL[7]
C09D 5/26 , B65D 23/08 , C09D 5/32

(52) UK CL (Edition V)
B8D DCW10 DFX
C3V VABN VABP VACN VACP

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(58) Field of Search
UK CL (Edition T) **B8D** DCE DCW10 DCW21 DCW9 DFX, **B8P** PK9, **C3V** VABN VABP VACN VACP
INT CL[7] **B65D** 23/02 23/08 25/34 81/00, **C09D** 5/26 5/30 5/32 5/33
Other: **Online: PAJ, WPI and EPODOC**

(54) Abstract Title
Environmentally Sensitive Bottle

(57) A coating composition for coating containers, methods for application of the coating composition to container surfaces and containers comprising a coat layer formed by application of a coating composition to one of the container surfaces is disclosed. The coating composition and coat layer are responsive to changes in environmental conditions to change one or more physical characteristics of the coating composition and/or coat layer. Specific embodiments disclose the incorporation of a uv light absorbing agent to the coating, which contains a coat-forming component of polyethylene or oleic acid, to prevent excess exposure of the container contents to uv radiation.

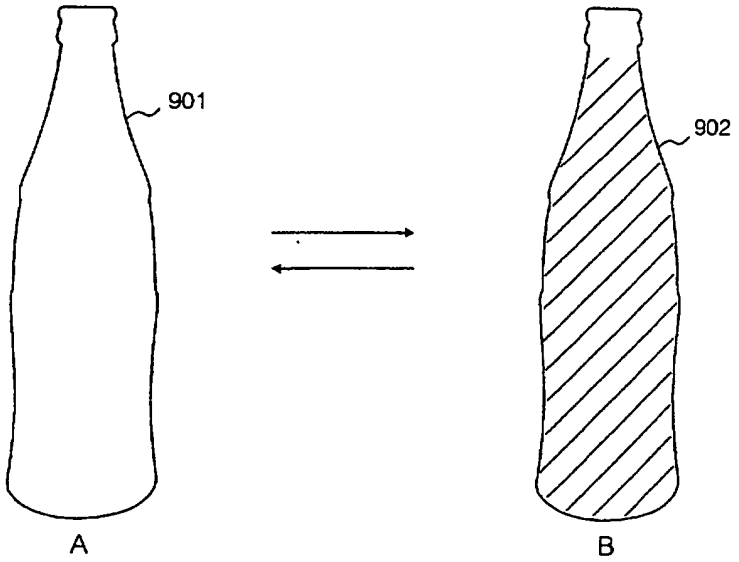

Fig. 9

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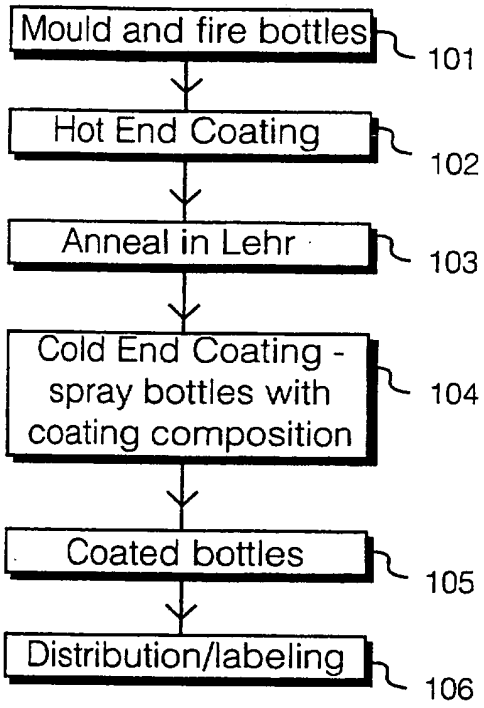

Fig. 1
(Prior Art)

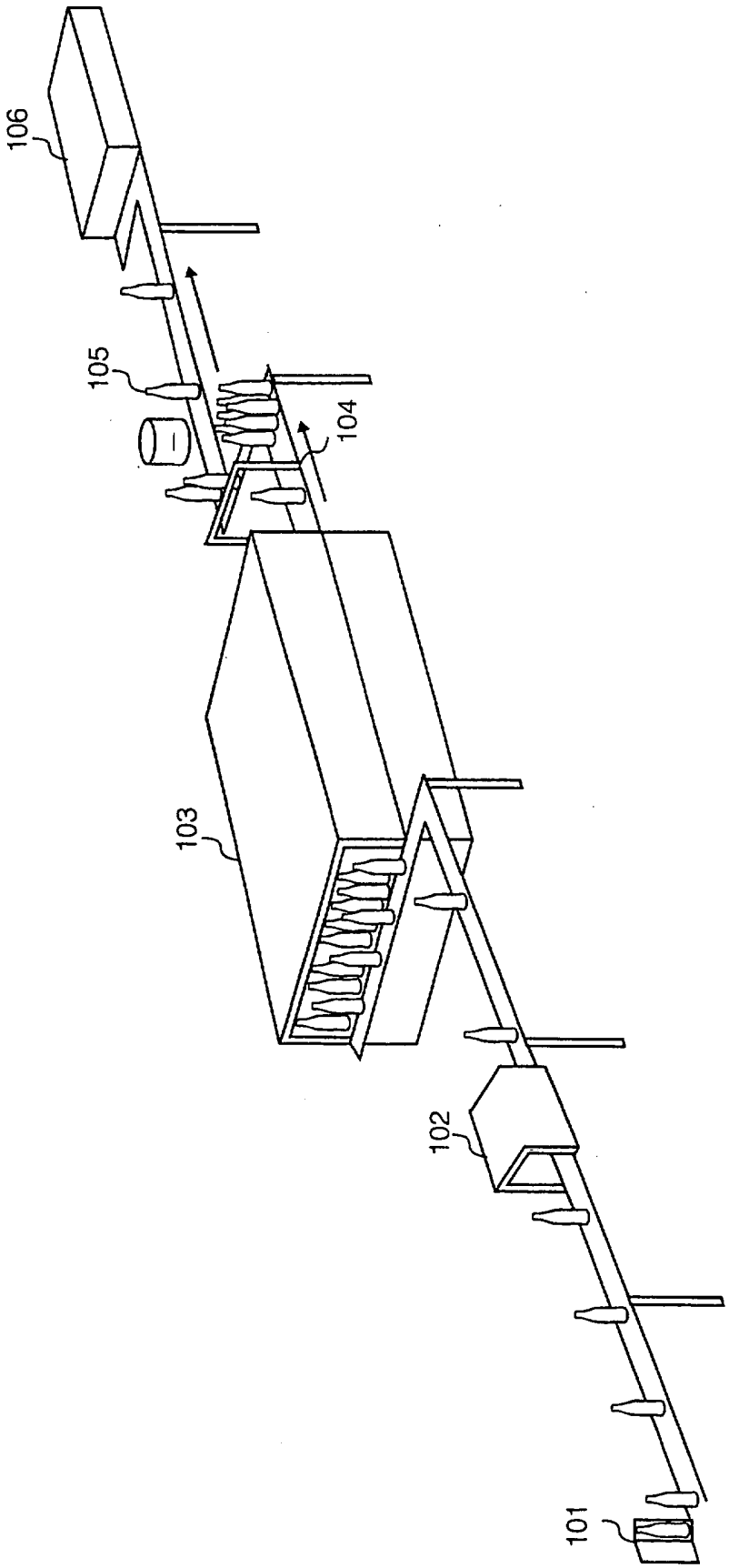

Fig. 2
(Prior Art)

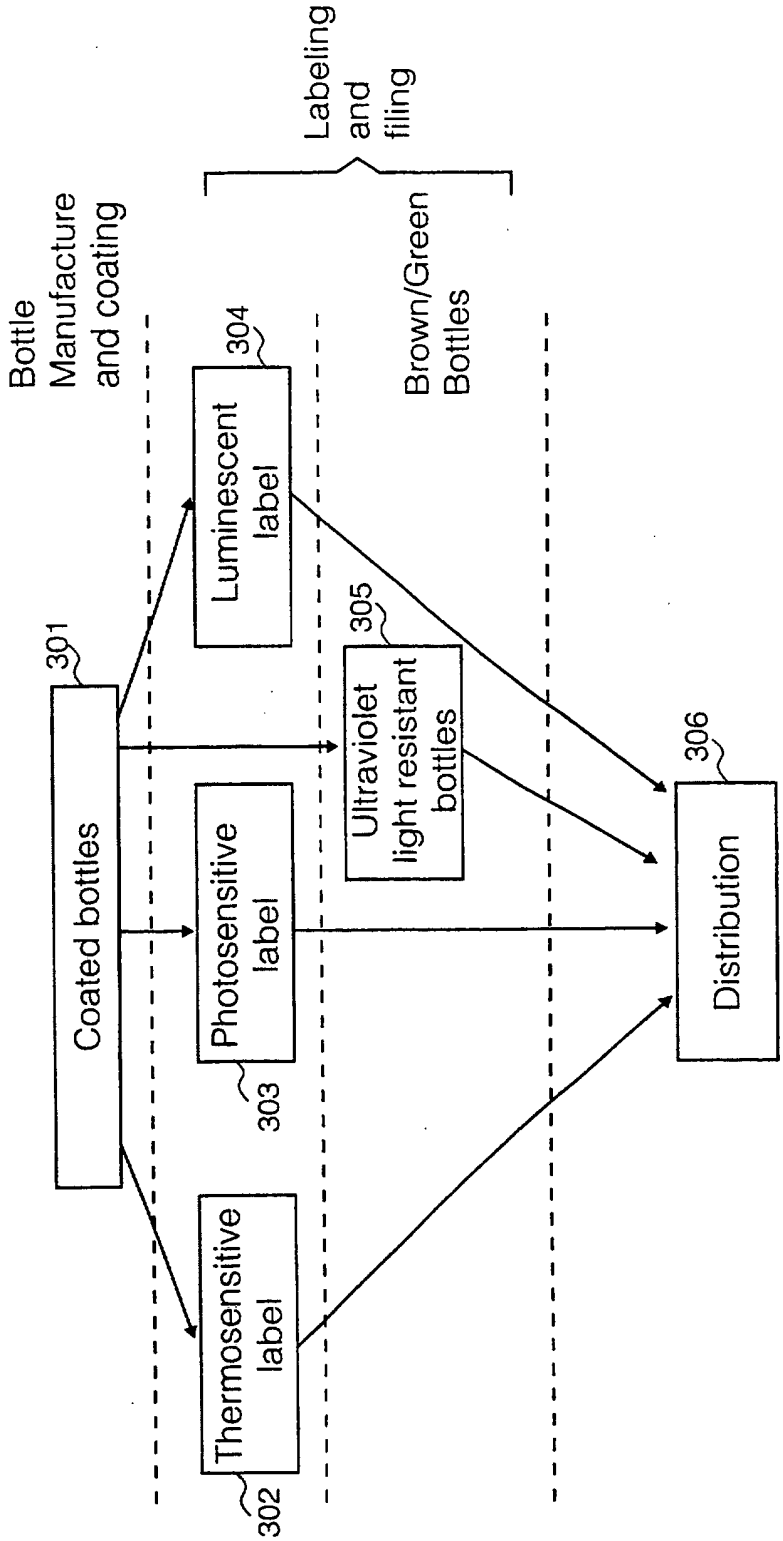

Fig. 3
(Prior Art)

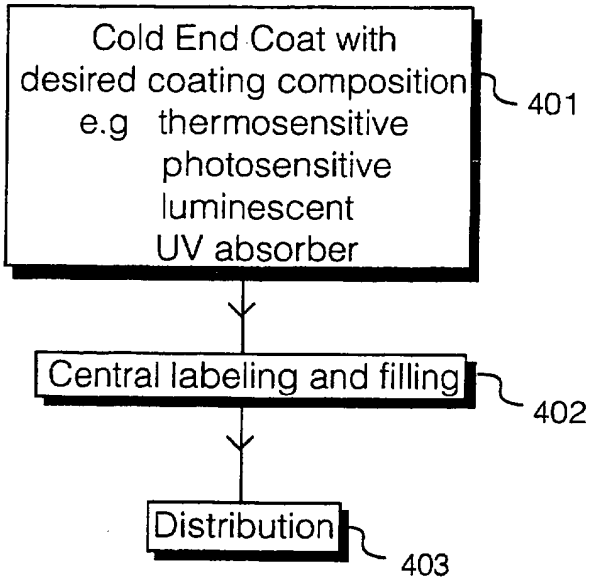

Fig. 4

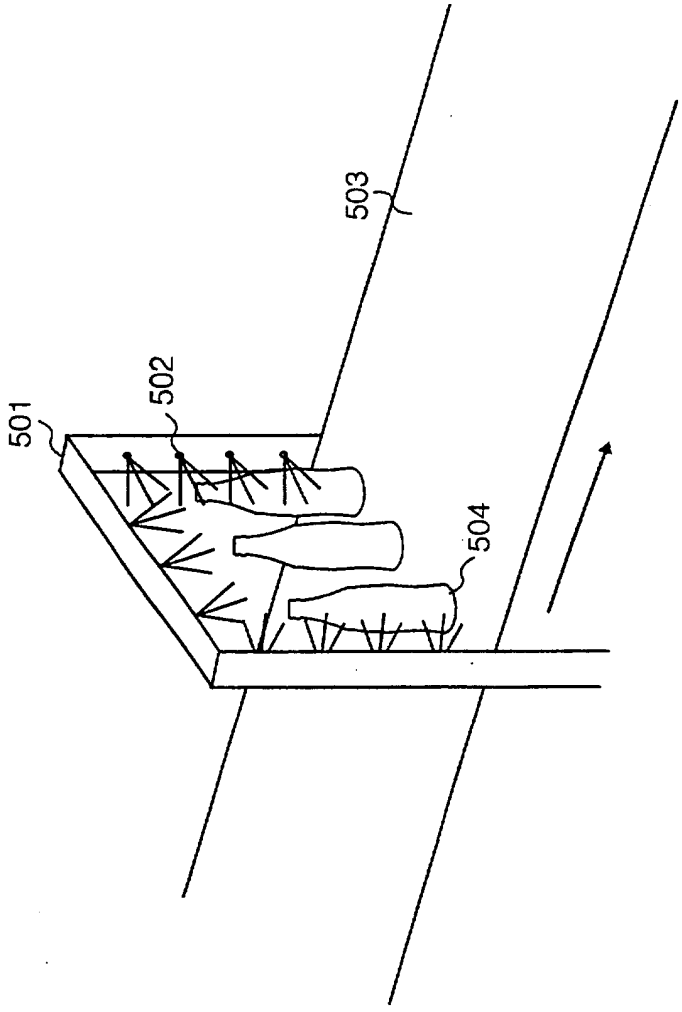

Fig. 5

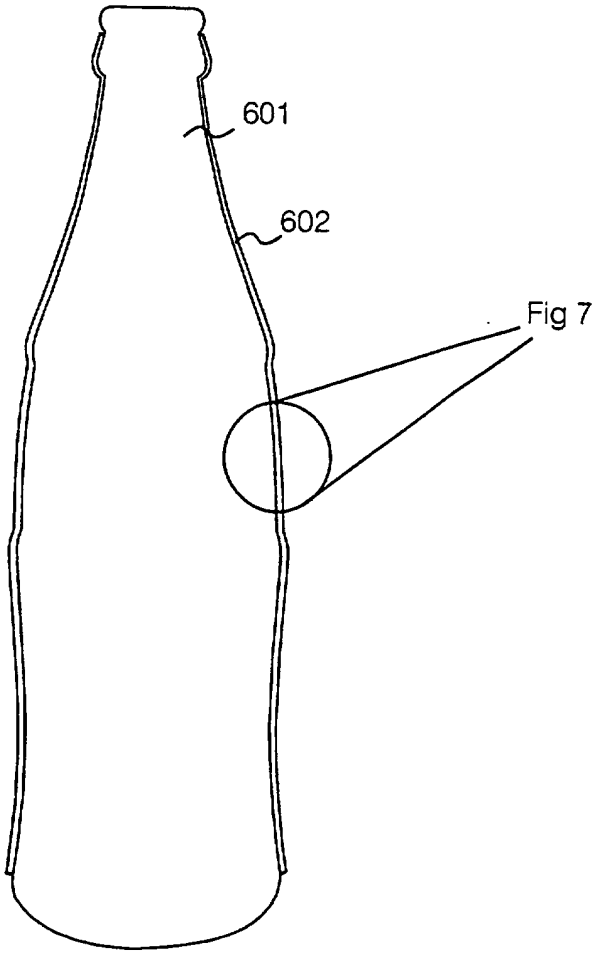

Fig. 6

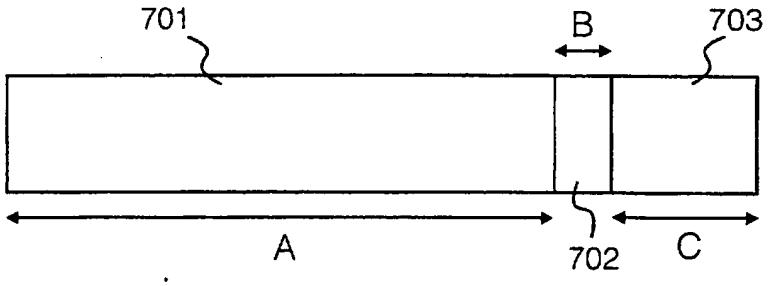

Fig. 7

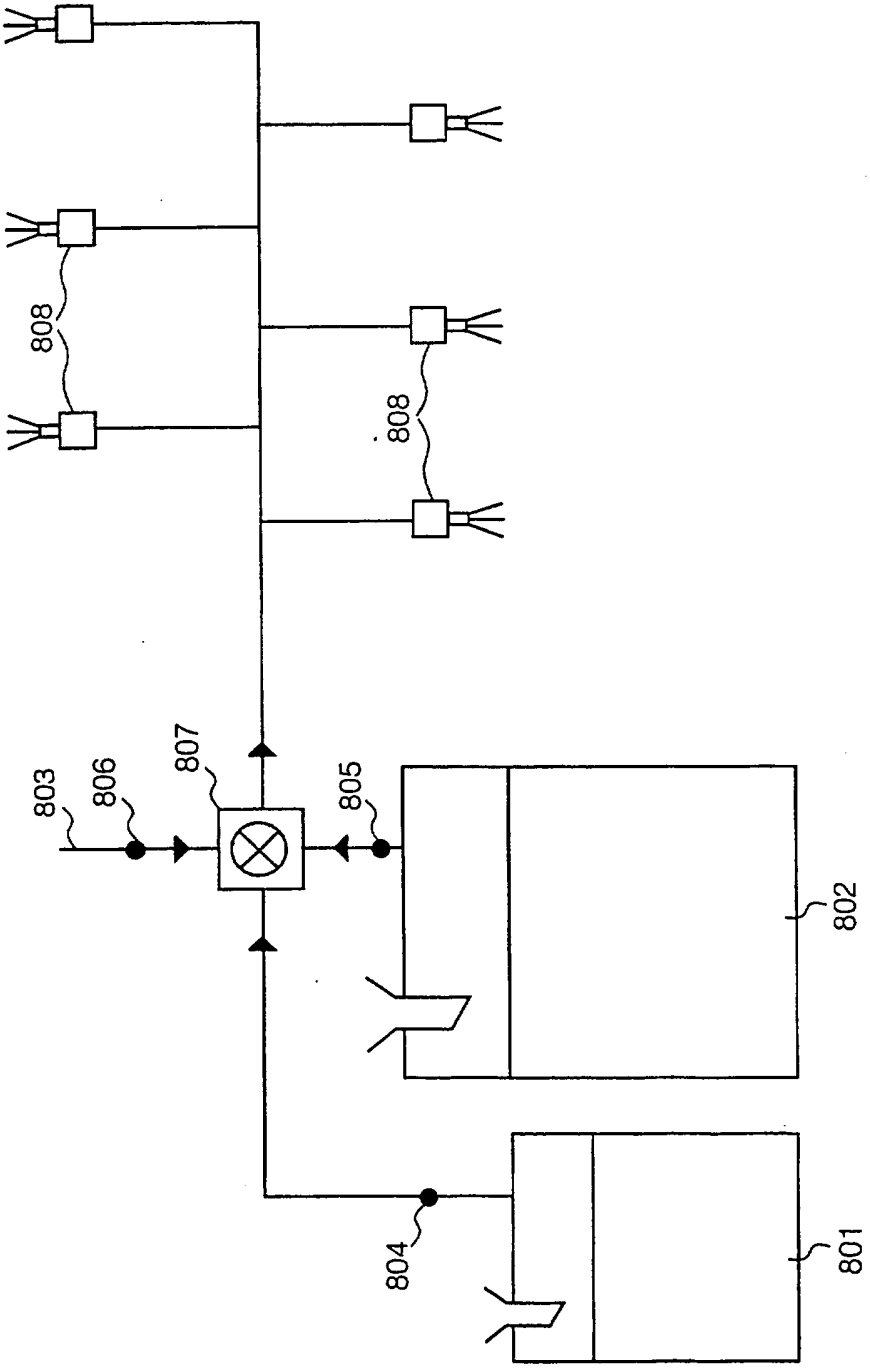

Fig. 8

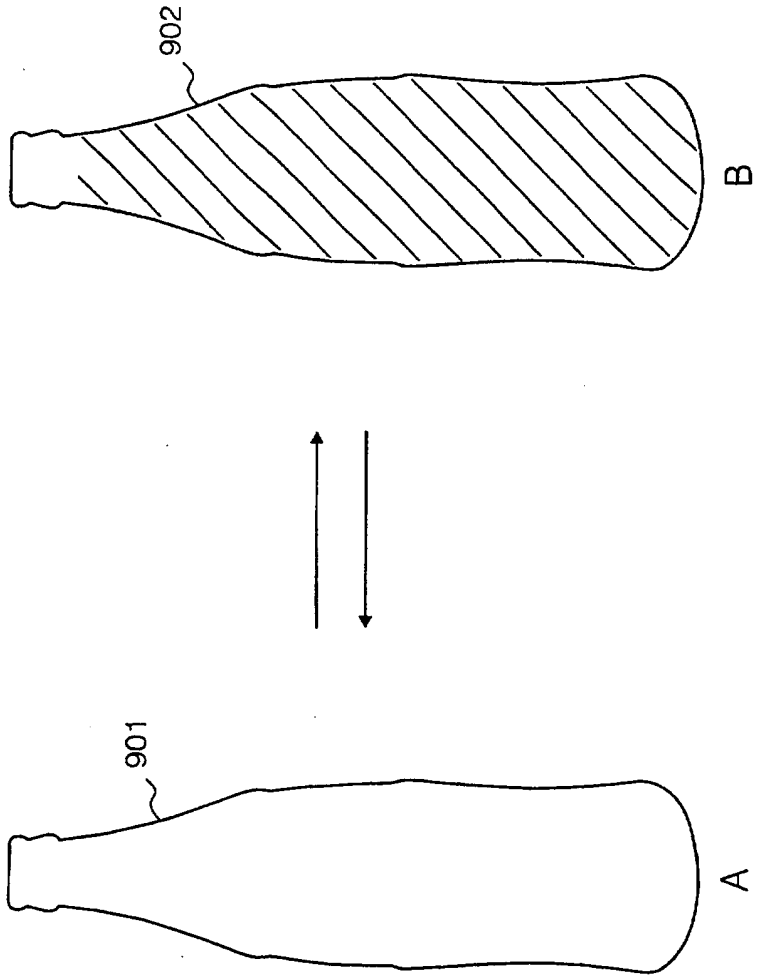

Fig. 9

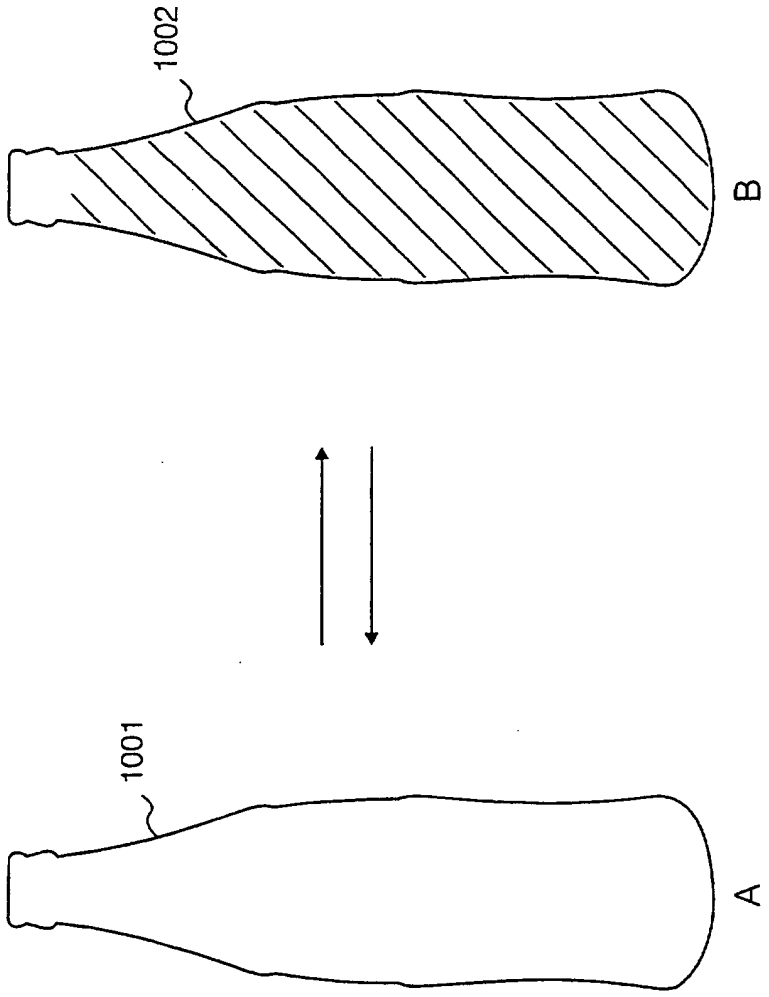

Fig. 10

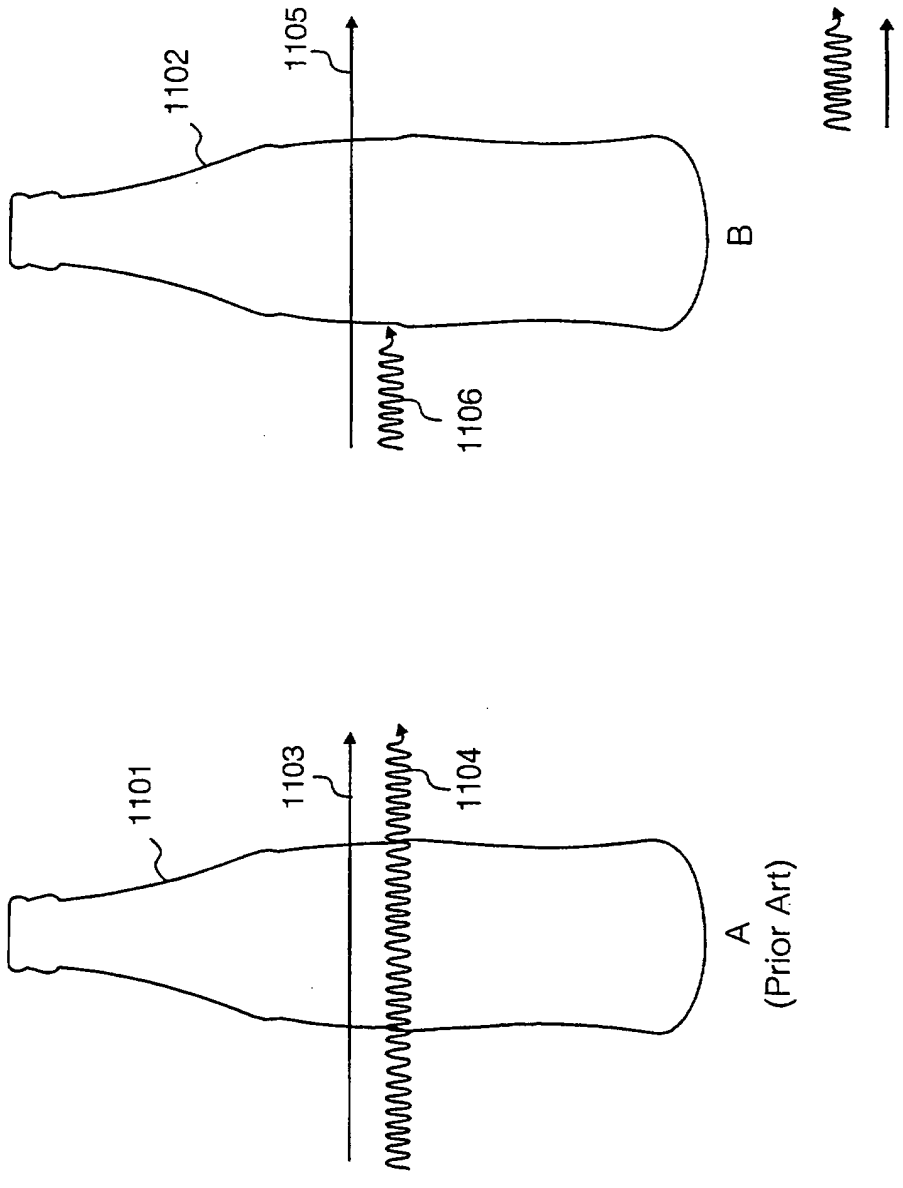

Fig. 11

ENVIRONMENTALLY SENSITIVE BOTTLE

Field of the Invention

The present invention relates to coating compositions and containers coated with a coating composition and particularly, although not exclusively, to coating compositions applied to the external surfaces of food and/or drink containers and their associated methods of application.

Background to the Invention

Glass for use in making containers e.g. glass bottles and jars for storage of food and/or drink are typically made by melting together silica, in the form of sand, soda ash and limestone together with certain specific additive elements, typically alkali earth metals and their oxides required to impart desired characteristics to the glass e.g. strength or alkali resistance.

It is known in the prior art to coat containers, particularly glass jars and bottles used for the containment and storage of food and/or drink items. A coat layer is applied to regions of the exterior surface of glass containers e.g. bottles upon formation of the container. Such layers comprise a thin layer of a coating material which is applied to the external surfaces of the container so as to be bonded thereto. The application of such coat layers has a number of advantages. Firstly, the coat layer acts to protect the external surfaces of the container to provide increased scratch resistance preventing dulling of the container surface. This improves the appearance of the container and helps maintain the improved appearance during transit of the container. Incorporation of a coat layer onto container external surfaces further provides a film layer on the container surface which acts as a lubricant being advantageous during processing of the containers in both the manufacturers and customers production lines resulting in increased levels of efficiency in the production, filling and labeling processes.

Fig. 1 illustrates schematically a process known in the prior art for the application of coat layers to glass bottles. Glass bottles are initially moulded and fired 101. A hot end coating (HEC)102 may then be applied to the bottle external surfaces. Hot end coatings typically comprise the application of a TiO_2 or SnO_2 coat using $TiCl_4$, $SnCl_4$ or $C_4H_9SnCl_3$ as the substrate. Hot end coating occurs whilst the bottles are still hot, typically at a temperature in the range 400 to 600°C and prior to annealing. The hot end coat provides a layer of protection to the glass walls and surfaces of the container and acts as a primer layer for the application of a cold end coat (CEC). Hot end coating is an optional stage. Bottles which have been moulded, fired and hot end coated where required are then passed into a lehr 103 where annealing of the glass occurs. Either within the lehr or shortly upon exiting the lehr a cold end coating is applied 104 to the external surfaces of the container. Cold end coatings are typically applied by means of spraying a coating composition towards the bottle so as to cover the external surfaces of the containers. Coated bottles 105 can then be processed, filled with the required contents and passed on for labeling and distribution 106.

The prior art process illustrated in Fig. 1 for formation and coating of glass bottles is illustrated diagrammatically in Fig. 2. Bottles are initially moulded and fired 101, optionally passed through a hot end coating treatment process 102 prior to annealing in an oven/lehr 103. Annealing typically occurs at temperatures in the range of 550°C, on entry of the bottles into the lehr 103, decreasing to temperatures in the range 200°C on exiting the lehr. Cold end coating 104 typically occurs in the temperature range 70 to 150°C and more typically in the range 80 to 100°C. Cold end coated bottles 105 are then passed on for distribution and labeling 106.

Whilst hot end coating improves the durability and wear properties of glass containers, it is the cold end coating which provides the increased scratch resistance, improved appearance and resultant increased production line processing efficiency due to the lubricating effect of the coating. Prior Art cold end coatings are typically applied to glass containers by the spraying of a coating

composition towards external surfaces of a container. Alternatively, it is possible to apply the coating by dipping of the container in a coating composition.

There are three types of known prior art coating compositions used to apply cold end coatings to glass containers. A first coating composition comprises an emulsion of polyethylene (also known as polyethylene and polythene) directly to the external surfaces of the container. A second type of coat is provided by the spraying of an emulsion of a polyester and a third prior art cold end coating is provided by the application of oleic acid. Typically, the coating composition is provided by a water based emulsion of a coat forming component e.g. polyethylene dispersed in water. Emulsifier agents, typically amphipathic agents e.g. stearate are known to be used to provide a stable emulsion.

The cold end coat formed by the prior art methods described above are typically thin film layers of coating composition permanently bonded to the external glass surface or underlying hot end coating.

At the end of the glass bottle formation process illustrated diagrammatically in Fig. 2, and schematically in Fig. 1, glass bottles are provided with a cold end coat. It is then necessary to process the bottles, for example filling them with a desired liquid and labeling the bottles. Whilst labels may be applied in the form of adhesively backed paper based labels onto which a description of the product is printed, it is becoming increasingly common for containers, particularly glass bottles, to incorporate a shrink wrap plastics label encapsulating the bottle, the label containing all of the product and manufacturers information, including brand names and trade marks. In certain circumstances such labels further contain a portion which is reactive to change its physical characteristics in response to a change in a local environmental condition. For example, JP 11076370A discloses use of a printed label on a bottle having a thermosensitive portion changing colour to indicate a change in temperature of the contents of the bottle.

Referring to Fig. 3 herein there is illustrated a bottle distribution arrangement required for the labeling of different bottles with a desired label. Cold end coated bottles 301 are required to be sorted and distributed as desired in order to be labeled with an appropriate thermosensitive 302, photosensitive 303 or luminescent label 304. Once the bottles have been appropriately labeled and filled they must then be reassembled at a distribution point 306.

Particular food and/or drink items are more sensitive to ultraviolet radiation. When such food and/or drink items are stored in ultraviolet light transparent containers the container contents are liable to deterioration. For example beer is commonly stored in bottles and is sensitive to ultraviolet radiation. Beer which has been exposed to ultraviolet radiation exhibits a change in taste which is sometimes known as "light struck" flavor. The common solution to this problem is to store beer in dark brown or green glass bottles which are less transparent to ultraviolet radiation than clear glass. Whilst this is reasonably effective at maintaining the shelf life of the beer contained within the glass bottles it is not a satisfactory solution as it does not enable long term storage of such products in transparent glass containers which improves the appearance and marketability of the product. Additionally, the requirement to manufacture a different colour of glass container in order to store such ultraviolet light sensitive food and/or drink products adds an additional logistical step between formation of the cold end coated bottles 301 and distribution 306.

Examples of coat layers applied to food and drink containers include US 5, 182,148 which discloses a water based thermosetting coating composition forming a transparent, coloured thermoset coating on application to a glass container. The coat may optionally include an ultraviolet light absorber. Typically, the film forming material comprises an acrylic polymer, polyester, polyether, an epoxy polymer, a polyurethane or a mixture of such materials.

DE 4213544A is an example of the application of a pigment layer to the walls of a container, the pigment containing a light absorbent component to

reduce the exposure of the container contents to incident radiation thus protecting the container from the external environment.

JP 63129038A discloses a glass bottle coated with a paint containing an ultraviolet light absorber component. The painted bottle is heated at 180°C for 20 minutes to cure the paint coating.

The multiple steps required to produce a coated container having an additional label which is responsive to change one of its physical characteristics in response to a change in a local external environmental condition are clearly disadvantageous and reduce the efficiency and increase the cost of the process of bottle formation, filling, labeling and distribution. There is therefore a need to improve the efficiency and reduce the cost of this process.

The lack of coating compositions and coat layers resultantly formed on container surfaces which are able to respond to changes in external environmental conditions by the change of one of the physical characteristics of the coat layer e.g. a colour change is indicative of the problem with prior art coating materials. At present, the existing solution relies on incorporation of separate labels additional to the coat layer which are applied to the container by an additional labeling or printing process to impart an environmental sensitivity to the container. These additional processes are also problematic introducing additional container processing steps with a resultant decrease in efficiency and increase in cost of the bottle production and processing operations.

The need to use coloured glass to provide a resistance to ultraviolet light and prevent deterioration of the contents of glass containers is an additional problem presented by the prior art.

The lack of thin film coat layers formed on container surfaces e.g. glass bottles which provide an ultraviolet light resistant or absorbing property to the coat layer is a problem presented by the prior art. In the prior art this problem is

solved to some extent by the use of dark green or dark brown bottles exhibiting greater ultraviolet light filtering properties then clear glass. The need to differentiate and sort coloured bottles from clear bottles introduces a sorting step to the bottle processing resulting in decreased efficiency and increased cost of the processing operations.

Summary of the Invention

The inventors have provided a coating composition applicable to container surfaces e.g. internal and external container wall surfaces to form a thin film coat layer. The coating composition is formed from a coat forming component comprising a coating medium of a water-based polyethylene or polyester emulsion or alternatively formed from substantially homogenous oleic acid. A reactive component is added to the coat forming component to form a coating composition which is responsive to changes in environmental conditions.

The reactive component may comprise a thermosensitive, photosensitive or water sensitive chemical entity. In specific embodiments thermochromic and photochromic compounds are incorporated as the reactive component to detect a change in surrounding environmental temperature or light intensity/wavelength, the coat layer formed exhibiting a colour change response. Thermochromic and photochromic agents include Zinc based inks and pigments and the Chromicolor® and Photopia® range of products produced by Matsui International Co. Inc.

By varying the percentage weight incorporation of a chosen reactive component into the coating composition a varying degree of sensitivity to changes in the external environmental conditions can be achieved.

The inventors have further provided a coating composition for the formation of thin film coat layers at either or both internal or external container wall surfaces which further comprises an ultraviolet light absorbing component which imparts to the coat layer an ultraviolet light filter and/or blocking function. Incident ultraviolet

light being partially or substantially entirely absorbed by the ultraviolet light absorbing agent. Glass containers coated with such a coat layer exhibiting significantly reduced levels of transmission of ultraviolet light radiation to the internal cavity and contents of the container.

One object of the present invention is to provide a coating composition for use in coating containers which is responsive to changes in enviromental conditions to change at least one physical characteristic of the coating composition.

A further object of the present invention is to provide containers having a coat layer applied to an internal or external surface, wherein the coat layer is formed by a coating composition responsive to changes in external environmental conditions to change at least one physical characteristic of the coat layer.

A further object of the present invention is to provide a coating composition for containers comprising an ultraviolet light absorbing component.

A further object of the present invention is to provide containers comprising a coat layer applied to an internal or external surface, said coat layer having ultra violet light absorbing properties.

A further object of the present invention is to improve the efficiency of production of containers comprising a layer responsive to changes in environmental conditions by the change of at least one physical characteristic of such layer.

According to a first aspect of the present invention there is provided a container comprising a coat layer formed on at least one container surface, said coat layer formed by a coating composition comprising:

a coat forming component; and

at least one component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coat layer changes in response to a local change in at least one environmental condition.

According to a second aspect of the present invention there is provided a coating composition for coating containers, said composition comprising:

a coat forming component; and

a component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coating composition changes in response to a local change in at least one environmental condition.

According to a first method of the present invention there is provided a method of coating containers comprising the step of:

applying a coating composition to a container surface to form a coat layer at said surface,

wherein said coating composition comprises:

a coat forming component; and

a component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coat layer changes in response to a local change in at least one environmental condition.

According to a third aspect of the present invention there is provided a container comprising a coat layer formed on at least one container surface, said coat layer formed by a coating composition comprising:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one component taken from the set of

- polyethylene;
- oleic acid.

According to a fourth aspect of the present invention there is provided a coating composition for coating containers, said coating composition comprising:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one taken from the set of:

- polyethylene;
- oleic acid.

According to a second method of the present invention there is provided a method of coating containers comprising the step of:

applying a coating composition to a container surface to form a coat layer at said surface,

wherein said coating composition comprises:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one taken from the set of:

- polyethylene;
- oleic acid.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Fig. 1 illustrates schematically the process of glass bottle formation and hot end and cold end coating known in the prior art;

Fig. 2 illustrates diagrammatically the prior art process of Fig. 1;

Fig. 3 illustrates schematically the spread distribution process known in the prior art for labeling glass bottles;

Fig. 4 illustrates schematically the streamlined manufacture, labeling and distribution process afforded by the present invention;

Fig. 5 illustrates diagrammatically cold end coating of glass bottles according to the present invention;

Fig. 6 illustrates diagrammatically a glass bottle having a coating layer deposited on the external glass surfaces in accordance with the present invention;

Fig. 7 illustrates a cross- section through the glass wall of a glass bottle processed according to the present invention illustrating the glass wall, hot end coating and cold end coating;

Fig. 8 illustrates schematically the formation and flow of a coating composition according to the present invention;

Fig. 9 illustrates diagrammatically a change of physical characteristics of a bottle coat layer according to the present invention in response to a variation in local external or internal temperature;

Fig. 10 illustrates a change in physical characteristics of a bottle coat layer according to the present invention in response to a variation in intensity or wavelength of incident radiation;

Fig. 11 illustrates diagrammatically a prior art type glass bottle in Fig. 11a and a bottle in accordance with the present invention in Fig. 11b illustrating the UV absorbency properties of bottles according to the present invention.

Detailed Description of the Best Mode for Carrying Out the Invention

There will now be described by way of example the best mode contemplated by the inventors for carrying out the invention. In the following description numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent however, to one skilled in the art, that the present invention may be practiced without limitation to these

specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the present invention.

In this specification the term thermosensitive describes the sensitivity of a material to vary or change a physical characteristic in response to a change in temperature including a response to either an increase or decrease in temperature. The term thermochromic in relation to a material describes a specific form of thermosensitivity of the material, the colour of the material and/or the intensity of such colour changeable in response to an increase or decrease in surrounding temperatures.

In this specification the term photosensitive in relation to a material describes the ability of such material to vary or change a physical characteristic or property in response to a change in incident light wavelength or intensity including either an increase or decrease in such wavelength or intensity. The term photochromic describes a particular form of photosensitivity describing the ability of a material to vary its colour, in response to a change in incident light intensity or wavelength.

In this specification the term luminescence describes the emission of light by a material upon excitation of said material by an energy source e.g. light or temperature. The term luminescence comprises both phosphorescence and chemiluminescence. The term thermoluminescence describes the luminescence of a material in response to a change in surrounding temperature.

In this specification the term translucent describes the characteristic or property of a material enabling only partial or defuse passage of light through said material. A first material is considered more translucent than a second material if the first material results in a decreased passage of light through said material. The material is considered transparent if it provides for the substantially uninterrupted passage of light through such material.

In this specification the term container comprises vessels and receptacles e.g. bottles, jars, mugs, laboratory glass ware, food and drink storage cartons and cans. Such containers are not limited to formation from specific materials. Examples of materials from which such containers are made comprises glass, plastics, metal and paper.

According to a first specific embodiment of the present invention there is provided a coating composition for use in applying a cold end coating to a container or vessel, typically a container for the storage of food and/or drink. In particular, the coating composition of the first embodiment is designed for forming a permanently applied coat layer to the external surfaces of a glass container e.g. a glass bottle.

In the first embodiment of the present invention the coating composition comprises a coat forming component. The coat forming component comprising one or a combination the following.

A first coat forming component comprises polyethylene (also known as polyethene or polythene) in the form of a water based emulsion. Polyethylene wax is mixed with an emulsifier agent being an amphipathic agent e.g. stearate in water to a dilution of between 20 to 25% polyethylene. A second coat forming component comprises polyester in the form of a water based emulsion of a polyester wax and emulsifier agent e.g. stearate to form an emulsion of approximately 20 to 25% polyester.

A third coat forming component comprises oleic acid, typically in the form of a substantially homogenous oleic acid composition.

In the first embodiment a coat forming component is chosen, for example polyethylene in the form of a 20 to 25% water based emulsion as described above. To this coat forming component an additional component is added. This additional component comprises a reactive component responsive to changes in

environmental conditions. In the first embodiment said reactive component is a thermosensitive component and particularly a thermochromic compound. The resulting coating composition thus comprises a coat forming component (a polyethylene emulsion) and a reactive component which is responsive to changes in temperature. Where a thermochromic reactive component is incorporated an increase or decrease in temperature has the effect of causing a change in colour of the coating composition. Various thermochromic components are known to the man skilled in the art. A desired thermochromic component is selected and blended with the coat forming component to effect a predetermined colour change throughout a predetermined temperature range.

Thermochromic inks and pigments are well known to the man skilled in the art. Matsui International Co. Inc. manufacture and supply thermochromic paints, inks, pigments and plastics designed to respond to an increase or decrease in temperature by change in appearance from one colour to another, or to a colorless appearance. These type of thermochromic products can be configured to respond to a chosen temperature range. Examples of suitable existing thermochromic products include the Matsui Chromicolor ® range. The Chromicolor ® range is available in a variety of inks, pigments, paints and plastic resin concentrates.

Selection of an appropriate thermosensitive reactive component enables a predetermined change in the physical characteristics of the coating composition, e.g. a change in luminescent intensity or degree of translucency or transparency of the coating composition, in response to a temperature change.

Application of the coating composition of the first embodiment of the present invention to a container, e.g. a glass bottle to form a surface coat layer on said bottle results in the formation of a glass bottle with an external coating exhibiting thermosensitive properties. For example application of a coating composition comprising a thermochromic reactive component to form a coat layer on such a bottle has the result that the coat layer undergoes a predetermined colour change

in response to a change in surrounding temperature through a predetermined range. The visual effect of this process being the appearance of a colour change of the external surface of the bottle to which the coat layer has been applied and subsequently a resultant change in the appearance of the colour of the contents of the bottle. For instance, application of a thermochromic coat composition to a transparent glass bottle containing water wherein the coat composition is substantially transparent at 0 to 4°C turning blue at temperatures greater than 8°C would have the effect that whilst the bottle is refrigerated the appearance of the contents is substantially transparent but once removed from the fridge and allowed to settle at ambient room temperature the contents of the bottle would appear blue.

Use of a thermoluminescent reactive component affords the ability to control the luminescence of the coat in response to temperature. Use of a reactive component responsive to temperature to adjust the translucency of the coating could be used to adjust the translucent or opaque appearance of the coat and thereby the container to which the coat has been applied.

A combination of reactive components, e.g. a thermochromic and thermoluminescent component could be combined in a single coating composition.

Referring to Fig. 5 herein there is illustrated in diagrammatic form a first specific method for the application of a coating composition of the present invention to a container surface. Figure 5 illustrates a plurality of glass bottles 504 mounted on a conveyor belt 503 wherein the glass bottles have just existed a lehr where annealing of the newly formed bottles has occurred. Glass bottles at this stage of manufacture are at a temperature in the range 80 to 150°C and more typically in the range 80 to 100°C. A framework 501 is mounted around conveyor 503. Mounted on framework 501 are a plurality of spray nozzles configured to spray a coating composition towards the external surfaces of the newly formed glass bottles 504. Spraying of the coating composition

substantially coats the external surfaces, neck, shoulders and main body of each glass bottle with a coating composition to form an external coat layer substantially covering the external surfaces of the glass bottle with the exception of the base portion.

Referring to Fig. 6 herein there is illustrated diagrammatically a bottle 601 having a coat layer 602 formed according to the first specific method of the present invention. A section of the coat layer 602 and glass wall is illustrated in cross section in Fig. 7. Fig. 7 illustrates the glass wall 701 of approximate thickness A = 1.5mm, an optional hot end coat e.g. of titanium oxide 702 of approximate thickness B = 10nm and a cold end coating e.g. of polyethylene and thermosensitive reactive component 703 of approximate thickness C = 50nm.

Fig. 8 illustrates diagrammatically an arrangement for the mixing and supply of a coating composition according to the present invention. The coat forming component base material e.g. polyethylene is stored in the form of a wax 802. Reactive component 801 is stored separately. A water supply 803 is further provided. Filters, 805, 804, 806 filter each component prior to mixing 807 to produce emulsion. An emulsifier may be added separately to the mixture. The emulsion as formed is directed to spray heads 808 for application of the coating composition to a desired container.

Referring to Fig. 9 herein there is illustrated diagrammatically a glass bottle coated with a thin film layer of the coating composition according to the present invention. Fig. 9a illustrates a glass bottle at a temperature of 0 to 4°C wherein the coat layer is substantially transparent. Increasing the temperature above approximately 8°C, as illustrated in Fig. 9b results in a predetermined colour change of the coat layer such that the bottle 902 takes on a coloured appearance. Where the coat layer remains transparent the internal contents of the bottle also take on a coloured appearance. Decreasing the temperature to the range 0 to 4°C results in the reversal of the colour change to the transparent coat of bottle 901 in Fig. 9a.

According to a second specific method of the present invention the coating composition is applied by dipping the container e.g. glass bottle into the coating composition to substantially coat the entire external surfaces of the container in a thin film layer of the coating composition. The bottle is then withdrawn from the composition retaining a thin film coating which upon drying and curing is permanently adhered to the bottle walls.

According to a second embodiment of the present invention there is provided a coating composition for use in coating containers e.g. glass bottles with a thin film coat layer. The coating composition comprising a coat forming component comprising a polyethylene emulsion typically comprising 20 to 25% polyethylene dispersed in water containing a suitable emulsifier additive. Optionally, a polyester based or oleic acid based coat forming component may be utilized as described above. In the second embodiment of the present invention the reactive component comprises a photosensitive chemical agent. The coating composition thus formed being responsive to changes in visible light intensity and/or visible light wavelength wherein visible light comprises electromagnetic radiation of wavelengths in the range 390nm to 780nm.

In the second embodiment of the present invention by varying the reactive component between varying available types of photosensitive or photochromic agents available to the man skilled in the art a predetermined colour change of the coat layer can be effected in response to a desired increase or decrease in light intensity or change in incidence of light wavelength at the coat layer. Incorporation of a photoluminescent reactive component into the coating composition results in a coat layer with varying luminescent properties responsive to variations in light intensity or wavelength of incident visible light.

Existing photocromic compounds known to the man skilled in the art include the Photopia ® range manufactured by Matsui International Co. Inc. these are a range of photochromic agents providing a light induced colour change

technology. Incorporation of such photochromic compounds into a product can be arranged to effect change of colour of a product from one colour to another when exposed to sunlight or ultraviolet light. Photopia® photochromic products are available in a range of formats including inks, pastes and paints. Customised colour changes can be created whilst a variety of known colour changes are available, each typically being a reversible colour change, examples including pink to magenta, blue to violet, colorless to purple, orange to red, green to olive, colorless to yellow, pink to orange, blue to green, purple to brown, colorless to blue, yellow to green, orange to brown, pink to purple, flesh coloured to sun tan coloured.

By selecting a suitable photosensitive reactive component predetermined variations in the degree of translucency of the coat layer responsive to variations in incident light intensity or wavelength can also be effected.

Referring to Fig. 10 herein there is illustrated in Fig. 10a a glass bottle 1001 coated with a photosensitive coat layer in dark or low light conditions. Exposure of the same bottle and coat layer to increased levels of light intensity, for example by exposure of the bottle to a light source of higher lux value, results in the coat layer undergoing a change in colour, luminescence or degree of translucency according to the type of photosensitive reactive component included in the coating composition. Fig. 10b shows a bottle 1002 having, for example a coloured coat layer formed in response to increased levels of light intensity whereas in dark conditions in Fig. 10a the bottle has a substantially transparent coat layer. By including an appropriate reactive component into the coating composition a change in a selected physical characteristic e.g. change in colour, degree of translucency or level of luminescence of the coat layer is achievable in response to detection of a change in incident light intensity or the wavelength of incident light, such light including both visible light in the range 390 to 780nm and ultraviolet light in the range 10nm to 390nm.

In a fourth specific embodiment of the present invention the reactive component incorporated into the coating composition for formation of the coat layer comprises a water sensitive reactive chemical agent incorporated into the coating composition. Varying the local level of humidity, being a measure of the percentage saturation of the surrounding environment, e.g. air, with water vapor at a given pressure, a change in the physical characteristics of the coat layer can be achieved. In one example, a coat layer applied to a bottle surface has a first colour e.g. blue at a first humidity level. Increasing the local humidity levels surrounding the coat layer to a second humidity level causing the coat layer to take on a transparent appearance.

Such a humidity responsive coat layer is not limited to changes in colour, changes in the degree of luminescence of the coat layer or transparency of the coat layer or a combination of changes in such physical characteristics of the coat layer being optional in response to incorporation of appropriate water sensitive reactive components into the coating composition.

In accordance with a fifth embodiment of the present invention there is provided a coating composition comprising a coat forming component e.g. a polyethylene or polyester water-based emulsion or oleic acid coat former further comprising an ultraviolet light absorber component being an ultraviolet light absorbing chemical entity. The coat forming composition thus formed exhibiting ultraviolet light absorption properties.

The coating composition typically comprises a water-based polyethylene emulsion comprising between 15 and 30% polyethylene and more typically between 20 and 25% polyethylene maintained as an emulsion by the inclusion of an appropriate amphipathic emulsifying agent e.g. stearate. This emulsion is further mixed with a UV light absorbing/blocking chemical agent to impart to the coating composition ultraviolet light resistant properties having the effect of at least partially reducing the transmission of ultraviolet light radiation through the

composition relative to a coat forming composition formed without an ultraviolet light absorber/blocking component.

A coat layer is formed at a container surface in accordance with the first or second specific method of the present invention described above. One example of a container being a glass bottle having a coat layer formed at the external surfaces of the bottle is illustrated in Fig. 6 which illustrates a thin film coat layer 602 formed by deposition of the coating composition at the external surfaces of a glass bottle to provide a protective coat layer providing increased scratch resistance and wear properties to the bottle. The coat layer is applied via a spraying or dipping method described in the first and second specific methods of the present invention causing the coating composition to be substantially bonded and adhered to the external glass surface of the bottle.

Ultraviolet light absorbing components suitable for use in the fifth embodiment of the present invention as described above include substituted benzophenones e.g. 2-hydroxybenzophenone, 2-(2-N-benzotriazol-2-yl)phenol or 2, 4', 4, 4' tetrahydroxybenzophenone typically incorporated in the range 0 to 5% by weight of the coating composition.

Referring to Fig. 11 herein there is illustrated in Fig. 11a a prior art type glass bottle 1101 which comprises a polyethylene, based coat layer applied to the external surfaces of the bottle to provide increased levels of scratch resistance, improved wear and lubrication to improve the efficiency of production and filling processes. This type of prior art bottle incorporates a coat layer having no specific advantageous properties for the reduction of ultraviolet light penetration into the internal cavity of the container. In such a prior art type bottle 1101 visible light 1103 and ultraviolet light 1104 pass through the bottle and contents with substantially little or no reduction in light intensity. The main reductions in light intensity levels being due to absorbance of energy by light absorbing substances e.g. food and/or drink contained within the cavity of the container.

Fig. 11b illustrates a bottle 1102 according to the fifth embodiment of the present invention. Fig. 11b illustrates a substantially transparent glass bottle 1102 having a coat layer in accordance with the fifth embodiment of the present invention, such coat layer comprising an ultraviolet light absorbing component. Fig. 11b illustrates diagrammatically that careful selection of a suitable ultraviolet light absorbing/blocking component into the coat layer enables substantially complete transmission of incident visible light 1105 with either partial or substantially complete blocking or absorption of ultraviolet radiation 1106 at the externally provided coat layer such as to diminish the exposure of the container contents to ultraviolet radiation incident at the container exterior walls.

Whilst in the prior art it has been necessary to use coloured glass, particularly dark brown and green glass to achieve this ultraviolet light filtering effect, the present invention provides for the use of transparent glass in the formation of transparent containers e.g. bottles wherein a substantially transparent coat layer can be formed at the external bottle surfaces which enables a higher degree of ultra violet light filtering to substantially reduce or completely remove the exposure of the bottle contents to ultraviolet light penetrating the container walls. This significantly improves both the transport life and shelf life of the container contents and is particularly relevant in the storage life and resultant quality of beer products stored in glass containers.

In addition by selecting an ultraviolet light resistant/absorbing compound to impart an ultraviolet filtration property to the coat layer of the fifth embodiment it is further possible to incorporate an environmentally sensitive reactive component which responds to changes in local environmental conditions causing change in the physical characteristics of the coat layer. For example, detection of incident ultraviolet radiation at the coat layer can be realized by causing a change in colour of the coat layer. By use of an appropriate ultraviolet light absorbing pigment responsive to incident ultraviolet radiation exposure of the coat layer to ultraviolet light can be indicated by a change in the coat layer colour.

Many ultraviolet light absorbing agents exhibit luminescent properties. This occurs when a luminescent agent absorbs energy in the form of ultraviolet light radiation promoting the energy state of the of the ultraviolet light absorbing agent which, on returning to an initial state, emits radiation in the visible light range, causing the compound to glow. Incorporating such a photoluminescent compound into the coating composition of the fifth embodiment, wherein the photoluminescent compound is responsive to radiation in the ultraviolet spectrum, provides a dual function coat layer. The first function being the filtration of ultraviolet radiation to protect the contents of the container or vessel coated with the coating composition. The second function of the ultraviolet light responsive compound being luminescence in response to the incident ultraviolet radiation. Such luminescence causing the coat layer to glow indicating exposure of the coat layer to ultraviolet radiation. Such a luminescent response has uses as a safety mechanism for indicating exposure to ultraviolet radiation as well as having applications in the improved appearance of containers being coated with a coat layer formed from deposition of such a coating composition.

According to a sixth embodiment of the present invention there is provided a coating composition comprising a coat forming component, for example a water based polyethylene emulsion as described above which further comprises more than one chemical entity taken from the set of:

- A thermosensitive agent;
- A thermochromic agent;
- A photosensitive agent;
- A photochromic agent;
- A luminescent agent;
- A thermoluminescent agent;
- An ultraviolet light absorbing or resistant agent.

A combination of more than one such agent with the coat forming component to form a coating composition has the result that the coating composition thus formed exhibits the properties of both components.

For example, a thermochromic agent and an ultraviolet light absorbing/resistant agent are incorporated into a water based polyethylene emulsion to form a coating composition. The coating composition is applied to a glass bottle by a spray method to form a thin film coat layer on the external surfaces of the glass bottle. The coat layer thus formed exhibits both thermochromic and ultraviolet light absorbing/resistant properties. Changing local environmental temperature values over a predetermined temperature range causing a change in colour of the coat layer due to sensitivity of the thermochromic agent to the change in temperature. Additionally, the ultraviolet light absorbing/resistant agent imparts to the coat layer an ultraviolet light filtration property significantly reducing or entirely blocking the transmission of ultraviolet light to the internal cavity of the container relative to the intensity of incident ultraviolet light at the container external surface.

A coating composition is provided which can be applied to external or internal surfaces of a container. Methods of application comprise the spraying of the coating composition under pressure towards the coated surface as well as dipping of the container in a solution of the coating composition or the painting of the coating composition to the container surfaces. Application of the coating composition results in formation of a thin film of the coating composition at the container surface which is firmly adhered to the container to form a permanent protective layer. Incorporation of a component, for example a chemical agent, ink or pigment to the coat composition such component being sensitive to changes in the surrounding local environmental conditions, detecting such changes and responding to them by exhibiting a change in one of a number of physical characteristics of the coat layer imparts an environmental sensitivity to the coat layer. Accordingly, the present invention enables formation of a coat layer comprising such a component which can respond to changes in surrounding

environmental conditions such as temperature, humidity, light intensity by varying one of a number of physical characteristics such as coat colour, the degree of transparency or translucency or the luminescent properties of the coat layer.

By incorporating an ultraviolet light absorbing component in the coating composition the properties of ultraviolet light absorption/resistance can be incorporated to the coat layer such that the coat formed at the container surface provides an ultraviolet light filtration property limiting the passage of ultraviolet light radiation beyond the coat layer.

Referring to Fig. 4 herein there is illustrated schematically the process steps between formation of a coat layer on a container by the process of cold end coating 401 and final distribution of the container 403. The present invention is advantageous in that the desired thermosensitive, photosensitive, luminescent or ultraviolet light responsive/absorbing agent is incorporated to the coat layer at the cold end coat stage. It is a simple process to adjust the required coating composition by variation of the additive component used to create the desired effect in the coat layer. This has the result that following cold end coating the coat layer comprises the desired environmentally sensitive properties such that the container can proceed straight to a labeling and filling stage 402. This is advantageous when compared to the prior art situation described in Fig. 3 wherein an initially coated bottle comprising a non environmentally responsive coat layer is required to be separately processed to receive suitably environmentally sensitive additional labels. Thus the present invention provides a significant streamlining in the manufacturing process enabling improved efficiency of container manufacture and processing at reduced cost.

Claims:

1. A container comprising a coat layer formed on at least one container surface, said coat layer formed by a coating composition comprising:

a coat forming component; and

at least one component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coat layer changes in response to a local change in at least one environmental condition.

2. A container as claimed in claim 1 wherein said physical characteristics comprise at least one characteristic taken from the set of:

- colour;
- degree of translucency;
- luminescent intensity.

3. A container as claimed in claim 1 or 2 wherein said environmental condition comprises at least one taken from the set of:

- temperature;
- humidity;
- intensity of incident radiation;
- wavelength of incident radiation;
- visible light intensity;
- visible light wavelength;
- ultraviolet light intensity;
- wavelength of ultraviolet light.

4. A container as claimed in any of claims 1 to 3 wherein said coat forming component comprises at least one taken from the set of:

- polyethylene;
- polyester;
- oleic acid.

5. A container as claimed in any preceding claim wherein said coat forming component is in the form of a water-based emulsion.

6. A container as claimed in claim 5 wherein said emulsion comprises 15 to 30% of said coat forming component.

7. A container as claimed in claim 5 wherein said emulsion comprises 20 to 25% of said coat forming component.

8. A container as claimed in claim 3 wherein visible light comprises light having a wavelength in the range 390nm to 780nm.

9. The coating composition as claimed in claim 3 wherein ultraviolet light comprises light having a wavelength in the range 10nm to 390nm.

10. A container as claimed in any preceding claim wherein said coating composition further comprises an ultraviolet light absorber component.

11. A container as claimed in claim 10, wherein said ultraviolet light absorber component comprises at least one taken from the set of:

- 2-hydroxybenzophenone;
- 2-(2-N-benzotriazol-2-yl)phenol;
- 2, 4', 4, 4'-tetrahydroxybenzophenone.

12. A container as claimed in any preceding claim wherein said container is made of glass.

13. A container as claimed in claim 12 wherein said glass is transparent.

14. A container as claimed in any preceding claim for use in storage of food and/or drink.

15. A container as claimed in any preceding claim wherein said container comprises a glass bottle comprising a thin film of said coat layer formed at an external surface of said bottle.

16. A coating composition ~~for coating containers~~, said composition comprising:

a coat forming component; and

at least one component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coating composition changes in response to a local change in at least one environmental condition.

17. A coating composition as claimed in claim 16 wherein said physical characteristics comprise at least one characteristic taken from the set of:

- colour;
- degree of translucency;
- luminescent intensity.

18. A coating composition as claimed in claim 16 or 17 wherein said environmental condition comprises at least one taken from the set of:

- temperature;
- humidity;
- intensity of incident radiation;
- wavelength of incident radiation;
- visible light intensity;
- visible light wavelength;
- ultraviolet light intensity;
- wavelength of ultraviolet light.

19. A coating composition as claimed in any of claims 16 to 18 wherein said coat forming component comprises at least one taken from the set of:

- Polyethylene;
- Polyester;
- Oleic acid.

20. A coating composition as claimed in any preceding claim wherein said coat forming component is in the form of a water-based emulsion.

21. A coating composition as claimed in claim 20 wherein said emulsion comprises 15 to 30% of said coat forming component.

22. A coating composition as claimed in claim 20 wherein said emulsion comprises 20 to 25% of said coat forming component.

23. A coating composition as claimed in claim 18 wherein visible light comprises light having a wavelength in the range 390nm to 780nm.

24. A coating composition as claimed in claim 18 wherein ultraviolet light comprises light having a wavelength in the range 10nm to 390nm.

25. A coating composition as claimed in any preceding claim wherein said coating composition further comprises an ultraviolet light absorber component.

26. A coating composition as claimed in claim 25, wherein said ultraviolet light absorber component comprises at least one taken from the set of:

- 2-hydroxybenzophenone;
- 2-(2-N-benzotriazol-2-yl)phenol;
- 2,4', 4, 4'-tetrahydroxybenzophenone.

27. A container comprising a body, at least a portion of said body coated with a coat layer, said coat layer formed by applying the coating composition claimed in any preceding claim to said container.

28. A container as claimed in claim 27 wherein said container is made of glass.

29. A container as claimed in claim 28 wherein said glass is transparent.

30. A container as claimed in any of claims 27 to 29 for use in storage of food and/or drink.

31. A glass bottle comprising a thin film coat layer formed at an external surface of said bottle, said coat layer formed by applying a coating composition as claimed in any of claims 16 to 26.

32. A method of coating containers comprising the step of:

applying a coating composition to a container surface to form a coat layer at said surface,

wherein said coating composition comprises:

a coat forming component; and

at least one component responsive to changes in environmental conditions,

wherein at least one of the physical characteristics of said coat layer changes in response to a local change in at least one environmental condition.

33. The method as claimed in claim 32, wherein said physical characteristics comprise at least one taken from the set of:

- colour;
- degree of translucency;
- luminescent intensity.

34. The method as claimed in claim 32 or 33 wherein said environmental condition comprises at least one taken from the set of:

- temperature;
- humidity;
- intensity of incident radiation;
- wavelength of incident radiation;
- visible light intensity;
- visible light wavelength;
- ultraviolet light intensity;
- ultraviolet light wavelength.

35. The method as claimed in any of claims 32 to 34, wherein said coat forming component comprises at least one taken from the set of:

- polyethylene;
- polyester;
- oleic acid.

36. The method as claimed in any preceding claim wherein said coat forming component is in the form of a water-based emulsion.

37. The method as claimed in 36 wherein said emulsion comprises between 15 to 30% of said coat forming component.

38. The method as claimed in claim 36 wherein said emulsion comprises between 20 to 25% of said coat forming component.

39. The method as claimed in any preceding claim wherein said coating composition further comprises an ultraviolet light absorber component.

40. The method as claimed in claim 39 wherein said ultraviolet light absorber component comprises at least one taken from the set of:

- 2-hydroxybenzophenone;
- 2-(2-N-benzotriazol-2-yl)phenol;
- 2,4', 4, 4'-tetrahydroxybenzophenone.

41. The method as claimed in claims 39 or 40 wherein said ultraviolet light absorber component comprises between 0-5% by weight of said coating composition.

42. The method as claimed in claim 34 wherein said wavelength of visible light is in the range 390nm to 780nm.

43. The method as claimed in claim 34 wherein said wavelength of ultraviolet light is in the range 10nm to 390nm.

44. The method as claimed in any of claims 32 to 43, application of said coating composition to said container surface occurring at a temperature in the range 70 to 150°C.

45. The method as claimed in any of claims 32 to 43, application of said coating composition to said container surface occurring at a temperature in the range 80 to 100°C.

46. The method as claimed in any of claims 32 to 45 wherein said container is made of glass.

47. The method as claimed in claim 46 wherein said glass is transparent.

48. The method as claimed in any of claims 32 to 47 wherein said container is suitable for the storage of food and/or drink.

49. The method as claimed in any of claims 32 to 48 wherein said container is made of glass, said method comprising the steps of:

forming and annealing the glass container prior to application of said coating composition; and

processing coated bottles.

50. A container comprising a coat layer formed on at least one container surface, said coat layer formed by a coating composition comprising:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one component taken from the set of

- polyethylene;
- oleic acid.

51. A container as claimed in claim 50 wherein said coat forming component comprises a water-based emulsion of polyethylene.

52. A container as claimed in claim 51 wherein said emulsion comprises between 15 to 30% polyethylene.

53. A container as claimed in claim 51 wherein said emulsion comprises between 20 to 25% polyethylene.

54. A container as claimed in any of claims 50 to 53 wherein ultraviolet light comprises light of a wavelength between 10nm and 390nm.

55. A container as claimed in any of claims 50 to 54 wherein said container is made of glass.

56. A container as claimed in claim 55 wherein said glass is transparent.

57. A container as claimed in claims 55 or 56 wherein said container is in the form of a bottle.

58. A container as claimed in any of claims 50 to 57 wherein said coat layer is substantially transparent.

59. A container as claimed in any of claims 50 to 57 wherein said container comprises a glass bottle comprising a thin film of said coat layer formed on the external surface of said bottle.

60. A coating composition for coating containers, said coating composition comprising:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one component taken from the set of:

- polyethylene;
- oleic acid.

61. A coating composition as claimed in claim 60 wherein said coat forming component comprises a water-based emulsion of polyethylene.

62. A coating composition as claimed in claim 61 wherein said emulsion comprises between 15 to 30% polyethylene.

63. A coating composition as claimed in claim 61 wherein said emulsion comprises between 20 to 25% polyethylene.

64. A coating composition as claimed in any of claims 60 to 63 wherein ultraviolet light comprises light of a wavelength between 10nm and 390nm.

65. A container comprising a body, at least a portion of said body coated with a coat layer, said coat layer formed by applying the coating composition as claimed in any of claims 60 to 64 to said container.

66. A container as claimed in claim 65 wherein said container is made of glass.

67. A container as claimed in claim 66 wherein said glass is transparent.

68. A container as claimed in claims 66 or 67 wherein said container is in the form of a bottle.

69. A container as claimed in any of claims 65 to 68 wherein said coat layer is substantially transparent.

70. A method of coating containers comprising the step of:

applying a coating composition to a container surface to form a coat layer at said surface,

wherein said coating composition comprises:

a coat forming component; and

an ultraviolet light absorber component,

wherein said coat forming component comprises at least one taken from the set of:

- polyethylene;
- oleic acid.

71. The method as claimed in claim 70 wherein said coat forming component comprises a water-based emulsion of polyethylene.

72. The method as claimed in claim 71 wherein said emulsion comprises between 15 to 30% polyethylene.

73. The method as claimed in claim 71 wherein said emulsion comprises between 20 to 25% polyethylene.

74. The method as claimed in any of claims 70 to 73 wherein ultraviolet light comprises light of a wavelength in the range 10nm to 390nm.

75. The method as claimed in any of claims 70 to 74 wherein said ultraviolet light absorber component comprises at least one taken from the set of:

- 2-hydroxybenzophenone;
- 2-(2-N-benzotriazol-2-yl)phenol;
- 2,4',4,4'-tetrahydroxybenzophenone.

76. The method as claimed in any of claims 70 to 75, application of said coating composition to said container surface occurring at a temperature in the range 70 to 150°C.

77. The method as claimed in any of claims 70 to 75, application of said coating composition to said container surface occurring in the temperature range 80 to 100°C.

78. The method as claimed in any of claims 70 to 77 wherein said coat layer is substantially transparent.

79. The method as claimed in any of claims 70 to 78 wherein said container is made of glass.

80. The method as claimed in claim 79 wherein said glass is substantially transparent.

81. The method as claimed in any of claims 70 to 80 wherein said container is suitable for storage of food and/or drink.

82. The method as claimed in any of claims 70 to 81 wherein said container is in the form of a bottle.

83. The method as claimed in any of claims 70 to 82 wherein said container is made of glass, said method further comprising the steps of:

forming and annealing the glass container prior to application of said coating composition; and

processing coated bottles.

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Application No: GB 0128548.5
Claims searched: 1-49

Examiner: Marian Challis
Date of search: 26 June 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B8D (DCE, DCW9, DCW10, DCW21, DFX) B8P (PK9) C3V (VABN, VABP. VACN, VACP)

Int Cl (Ed.7): B65D 23/08, 23/02, 25/34, 81/00, C09D 5/26, 5/30, 5/32, 5/33,

Other: Online: PAJ, EPODOC and WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2316385	(UNILEVER PLC) Page 3 lines 1-21	1-3,12-18,27-31
X	GB 2262938	(UKAE LTD.) Pages 2,3 lines 16-27 and 1-24 respectively	1,3,4,10-16,18,19,25-32,34,35,39-43,46-48
X	DE 3628635	(KUEHL) Whole document	1–4,12,14-18 27,28,30-34,46,48
X	JP 2001131486	(NIPPON PAINT CO. LTD.) Abstract AN: 2001-544148	1-5,12-20,27-36,46-48
X	JP 11021479	(PILOT INK CO. LTD.) Abstract AN: 1999-316052	1-3,14,16-18 27,30,31-34,48

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

BNSDOCID: <GB_____2382560A_I_>

Application No: GB 0128548.5
Claims searched: 1-49

Examiner: Marian Challis
Date of search: 26 June 2002

Category	Identity of document and relevant passage		Relevant to claims
X	JP 63129038	(KOA GLASS CO.) Abstract AN: 1988-192970	1,3,4,9,10, 12-16 18,19,24, 25,27-35 39,41, 43,46-49
X	JP 56077191	(TOYO INK MFG CO.) Abstract AN: 1981-59286 D	1-4,14, 16-19 27,30,32-35,42

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

BNSDOCID: <GB_____2382560A__I_>

40-

Application No: GB 0128548.5
Claims searched: 50-83

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Databases searched:

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Int Cl (Ed.7): B65D 23/08, 23/02, 25/34, 81/00, C09D 5/30, 5/32

Other: Online: PAJ, EPODOC and WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	JP 9048935	(MITSUBISHI RAYON CO.) Abstract AN: 1997 - 188453	-
A	JP 6142611	(FUJIKURA KASEI KK) Abstract AN: 1994 - 205301	-
X	JP 61209927	(FUJIKURA KASEI KK) Abstract AN: 1986 - 287859	51,54-60,64-70,74,75,78-82

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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

BNSDOCID: <GB_____2382560A__I_>